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PATENT SPECIFICATION

(11) 1 291 388

NO DRAWINGS

(21) Application No. 7615/70 (22) Filed 17 Feb. 1970
(31) Convention Application No. 2400 (32) Filed 21 Feb. 1969 in
(33) Sweden (SW)
(45) Complete Specification published 4 Oct. 1972
(51) International Classification C23C 11/08
(52) Index at acceptance
C7F 1B2 2M 2Z2 2Z5 4E 4F 4K

(54) IMPROVEMENTS IN OR RELATING TO SINTERED CARBIDE BODIES FOR THE MACHINING OF STEEL AND THE LIKE

(71) We, SANDVIKENS JERNVERKS AKTIEBOLAG, a Swedish Body Corporate, of Sandviken, Sweden, do hereby declare the

has been accomplished by sintering both the body (A) and layer (B) containing binder metal.

SPECIFICATION NO 1291388

By a direction given under Section 17 (1) of the Patents Act 1949 this application proceeded in the name of SANDCO LIMITED, a Corporation organised under the laws of Canada, of 160 Elgin Street, Ottawa, Canada, K1N8 S3.

THE PATENT OFFICE

R 16775/4

artificial material. Such inserts can be fastened to a cutting tool by clamping, soldering or by other means and may for instance take the form of a plate having cutting edges between one or both end faces of the plate and one or more side surfaces. The end or end faces constitute(s) a chip face or chip faces and the side edge(s) constitute(s) a clearance face or clearance faces. Our co-pending Application 95/70 (Serial No. 1,247,831) is also concerned with such inserts. Reference may also be made to our co-pending Application 7500/70 (Serial No. 1,291,387) which refers to the production of coated sintered hard metal bodies.

The kind of insert with which the present invention is concerned is an insert comprising (A) an insert body of sintered hard metal alloy consisting of metallic carbide comprising tungsten carbide and/or titanium carbide and/or tantalum carbide bound with a binder metal comprising cobalt and/or nickel and/or iron and/or chromium, on which body a layer (B) with higher wear resistance than that of the hard metal is applied.

It is previously known how to apply a layer (B) of higher wear resistance to a cemented carbide body (A). These previously proposed layers (B) have in general been constituted by a cemented carbide having a different composition from that of body (A), for instance having a higher TiC content than that of body (A). The preparation of a body (A) coated with layer (B) layer comprising carbide of higher wear-resistance than body (A) applied to the body (A), wherein layer (B) has been applied to body (A) by deposition from gaseous phase at a pressure less than atmospheric pressure and comprises fine-grained titanium carbide with or without any of the group consisting of tungsten carbide, tantalum carbide and niobium carbide, the carbide(s) of layer (B) having a carbon content which is below the carbon content of the stoichiometric composition of the appropriate carbide(s).

Preferably, layer (B) is composed of an inner fine-grained region with a mean grain size of 0.02—0.15 μm, e.g. 0.10 μm, adjacent to the body (A) and an outer courser-grained region with a mean grain size of 0.2—0.4 μm, e.g. 0.3 μm. The heterogeneous structure of layer (B) may be obtained by temperature variation during deposition of layer (B) on body (A).

The layer (B) may have a carbon content corresponding to 0.5 to 0.9 of the stoichiometric carbon content. For instance, titanium carbide corresponds stoichiometrically to 80% by weight of titanium and 20% by weight of carbon, and thus a layer (B) comprising titanium carbide will generally need to have a carbon content exceeding 10% by weight, but preferably not exceeding 15% by weight.

The application of the carbon layer (B) is achieved, as mentioned previously by precipitation from a gaseous phase, with the modification, that the conditions of de-

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(54) IMPROVEMENTS IN OR RELATING TO SINTERED CARBIDE BODIES FOR THE MACHINING OF STEEL AND THE LIKE

(71) We, SANDVIKENS JERNVERKS AKTIEBOLAG, a Swedish Body Corporate, of Sandviken, Sweden, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to inserts for machining steel or other material, and especially to inserts for chipforming-machining of steel or other metal or an artificial material. Such inserts can be fastened to a cutting tool by clamping, soldering or by other means and may for instance take the form of a plate having cutting edges between one or both end faces of the plate and one or more side surfaces. The end or end faces constitute(s) a chip face or chip faces and the side edge(s) constitute(s) a clearance face or clearance faces. Our co-pending Application 95/70 (Serial No. 1,247,831) is also concerned with such inserts. Reference may also be made to our co-pending Application 7500/70 (Serial No. 1,291,387) which refers to the production of coated sintered hard metal bodies.

The kind of insert with which the present invention is concerned is an insert comprising (A) an insert body of sintered hard metal alloy consisting of metallic carbide comprising tungsten carbide and/or titanium carbide and/or tantalum carbide bound with a binder metal comprising cobalt and/or nickel and/or iron and/or chromium, on which body a layer (B) with higher wear resistance than that of the hard metal is applied.

It is previously known how to apply a layer (B) of higher wear resistance to a cemented carbide body (A). These previously proposed layers (B) have in general been constituted by a cemented carbide having a different composition from that of body (A), for instance having a higher TiC content than that of body (A). The preparation of a body (A) coated with layer (B) has been accomplished by sintering both the body (A) and layer (B) containing binder metal.

According to the present invention we provide an insert for machining of steel or the like comprising (A) an insert body of sintered hard metal alloy consisting of metallic carbide comprising tungsten carbide and/or titanium carbide and/or tantalum carbide bound with a binder metal comprising cobalt and/or nickel and/or iron and/or chromium, and (B) a surface layer comprising carbide of higher wear-resistance than body (A) applied to the body (A), wherein layer (B) has been applied to body (A) by deposition from gaseous phase at a pressure less than atmospheric pressure and comprises fine-grained titanium carbide with or without any of the group consisting of tungsten carbide, tantalum carbide and niobium carbide, the carbide(s) of layer (B) having a carbon content which is below the carbon content of the stoichiometric composition of the appropriate carbide(s).

Preferably, layer (B) is composed of an inner fine-grained region with a mean grain size of 0.02—0.15 μm, e.g. 0.10 μm, adjacent to the body (A) and an outer courser-grained region with a mean grain size of 0.2—0.4 μm, e.g. 0.3 μm. The heterogeneous structure of layer (B) may be obtained by temperature variation during deposition of layer (B) on body (A).

The layer (B) may have a carbon content corresponding to 0.5 to 0.9 of the stoichiometric carbon content. For instance, titanium carbide corresponds stoichiometrically to 80% by weight of titanium and 20% by weight of carbon, and thus a layer (B) comprising titanium carbide will generally need to have a carbon content exceeding 10% by weight, but preferably not exceeding 15% by weight.

The application of the carbon layer (B) is achieved, as mentioned previously by precipitation from a gaseous phase, with the modification, that the conditions of de-

position will result in a deficit of carbon in the layer applied. According to one mode of procedure the body (A) may pass through a prior decarbonizing operation which may be performed for instance by applying decarburizing material as for instance certain forms of Al_2O_3, TiO_2 or other oxides when sintering.

It has furthermore been found advantageous for layer (B) to include at least 0.5% and preferably at the most 3 to 5% by weight O and/or N in the form of finely dispersed oxide and/or nitride, for instance Ti-oxides and/or -nitrides, having for example 0.01—0.05 μm average grain-size.

A further improvement of the bond between layer (B) that part of body (A) which is adjacent to layer (B) and body (A) and an increased resistance of the insert to i.a. thermoshocks and mechanical impact stresses has been obtained when has a lower carbon content than that of the remainder of body (A). This decarburized part of body (A) may for instance be produced by the aforementioned procedure of decarburizing but it is advantageous to regulate the procedure of carbide precipitation so that the hard metal body (A) itself substantially emits the requisite amount of carbon in forming the carbide surface layer and thereby becomes decarburized. The hard metal body (A) in this case may apart from binder metal contain such hard substances, which have been found to constitute carbon-emitters, as for instance carbides or W, Mo and/or Cr, where WC is preferably included. In this way the composition of the said decarburized part of body (A) will correspond to certain phases with low carbon content in the three-component-system W-Co-C, principally the so-*eta* called phase, generally written Co_3W_3C, a well-known structure constituent *per se* in the cemented carbide field. It has often been found advantageous to substitute Co wholly or partially with Fe, Ni and/or Cr in the said *eta*-phase.

The said decarburized part of body (A) should desirably be uniformly developed and have a thickness in the range of 1—12 μm, preferably greater than 3 μm and suitably less than 10 μm. Here and elsewhere in the Specification μm denotes microns.

The following example illustrates the conditions under which sintered hard metal bodies have been coated with TiC, the deposition taking place in an apparatus of conventional type.

EXAMPLE

About 1000 pieces of square inserts of hard metal (A) containing 80 parts by weight WC, 10 parts by weight Co and 20 parts by weight carbides of cubic crystal structure in the form of TiC, TaC and NbC were placed in a retort and treated with hydrogen at a pressure of 1 atmosphere. Thereupon a gas with the composition (in % by volume) 96 H_2, 3.5 $TiCl_4$ and 0.5 C_2H_2 was passed through the charge. The gas pressure was 25 mm Hg and the reaction took place at 875°C. The coating (B) obtained had a thickness of 3 μm (microns) after 4 hours. The metallographic and physical examinations showed *i.a.* that the surface layer of TiC had a carbon content of 13% by weight and was composed of an inner fine-grained region with a grain size of 0.1 μm adjacent the insert body (A) and an outer region with a grain size of 0.3 μm.

A comparison will now be made in the field of cutting between inserts having an insert body (A) coated with a carbide layer (B) in accordance with this invention and normal uncoated inserts or inserts coated in accordance with prior proposals. The specific operation concerned is the turning of carbon steel having a C-content of 0.8%. Tool wear measurements after a predetermined cutting time at given constant cutting conditions are compared.

Insert	Flank wear or cratering		
	Flank wear	Crater depth	Time
Normal uncoated	0.89 μm	295 μm	15 min.
Coated according to the above Example of the invention	0.11 μm	<5 μm	15 min.
Coated according to prior procedure ...	0.68 μm	48 μm	15 min.

The composition of the hard metal was in % by weight: 9.5 Co, 12 TiC, 6 TaC, 4 NbC and the remainder WC, i.e. the body (A); the layer (B) was applied in the same manner and had the same composition as described in the Example.

The cutting conditions were:

Cutting speed:	120 m/min.
Feed:	0.30 mm/rev.
Cutting depth:	2.0 mm
Entering angle:	75°

WHAT WE CLAIM IS:—

1. An insert for machining of steel or the like comprising (A) an insert body of sintered hard metal alloy consisting of metallic carbide comprising tungsten carbide and/or titanium carbide and/or tantalum carbide bound with a binder metal comprising cobalt and/or nickel and/or iron and/or chromium, and (B) a surface layer comprising carbide of higher wear-resistance than body (A) applied to the body (A), wherein layer (B) has been applied to body (A) by deposition from gaseous phase at a pressure less than atmospheric pressure and comprises fine-grained titanium carbide with or without any of the group consisting of tungsten carbide, tantalum carbide and niobium carbide, the carbide(s) of layer (B) having a carbon content which is below the carbon content of the stoichiometric composition of the appropriate carbide(s).

2. An insert according to Claim 1, wherein layer (B) has a carbon content corresponding to 0.5 to 0.9 of the stoichiometric carbon content.

3. An insert according to Claim 1 or Claim 2, wherein layer (B) comprises titanium carbide having a carbon content exceeding 10% by weight.

4. An insert according to Claim 3, wherein layer (B) has a carbon content not exceeding 15% by weight.

5. An insert according to any preceding claim, wherein layer (B) includes at least 0.5% by weight of oxygen and/or nitrogen present in the form of finely dispersed oxide and/or nitride.

6. An insert according to Claim 5, wherein layer (B) includes 3 to 5% by weight of oxygen and/or nitrogen present in the form of finely dispersed oxide and/or nitride.

7. An insert according to any preceding claim, wherein layer (B) is composed of an inner fine-grained region with a mean grain size of 0.02—0.15 μm adjacent to the body (A) and an outer coarser-grained region with a mean grain size of 0.2—0.4 μm.

8. An insert according to any preceding claim, wherein that part of body (A) which is adjacent to layer (B) has a lower carbon content than that of the remainder of body (A).

9. An insert according to Claim 8, wherein the said part of body (A) which is adjacent to layer (B) comprises a low carbon *eta* phase in the W/Co/C system.

10. An insert according to Claim 9, modified in that the Co content of the low carbon *eta* phase is replaced wholly or partially by Fe and/or Ni and/or Cr.

11. An insert according to Claim 7, or any claim appendant thereto, wherein the thickness of the said part of body (A) which is adjacent to layer (B) is 1 to 12 μm.

12. An insert according to Claim 11, wherein the said part of body (A) has a thickness greater than 3 μm.

13. An insert according to Claim 11 or Claim 12, wherein the said part of body (A) has a thickness less than 10 μm.

14. An insert according to Claim 1 substantially as herein described and exemplified.

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Printed for Her Majesty's Stationery Office by Burgess & Son (Abingdon), Ltd.—1972.
Published at The Patent Office, 25 Southampton Buildings, London, WC2A 1AY,
from which copies may be obtained.